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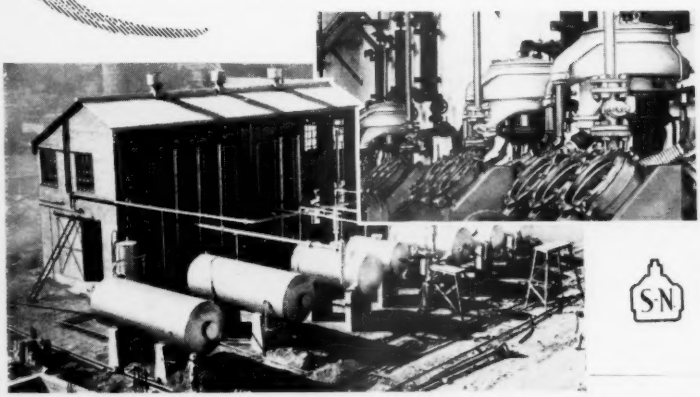

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THE IMPORTANCE OF ACCURACY IN OIL MEASUREMENT

By H. R. HOLMES*

ACCURACY in oil measurement involves accurate engineering and mathematical work, the use of carefully calibrated and standardized equipment, and the skill and experience of the oil gauger. The accounting operations of the cashier are simple, and he can regard these as foolproof, but the oil accountant has to take into consideration losses resulting from leakage and evaporation. The exactitude of the cashier's balance cannot be attained in oil measurement, but in recent years improvement in procedure and apparatus have removed many sources of error. Constant errors in one direction can prove very costly and it is these which should be weeded out.

Accuracy in oil measurement is essential for the avoidance of disputes on quantities, and is the only reliable means of securing adequate control over storage, transport and distribution losses. These losses are equivalent to losses in cash, and the importance of accuracy increases with the value of the oil handled. In late years an increase in oil values has made close attention to improvements in oil measurement procedures all the more imperative.

The operations involved in oil measurement must be safe and, more-

* Shell Petroleum Co. Ltd., S.T.A. Dept. (Oil Measurement & Loss Control Section).

over, should not make undue demands upon the oil gauging personnel whose interest in their tasks must be kept at a high level if a high standard of accuracy is to be maintained. An oil company must ensure that full measure is received for any oil that it purchases and, if the company has its own wells, that a complete and accurate record is kept of all oil produced. Care must be taken to ensure that purchasers are given full measure without over-delivery taking place. Local official regulations vary from area to area, and these must be met. Accurate measurement will ensure that royalties and import duties are neither underpaid nor overpaid.

BULK OIL MEASUREMENT METHODS

Before considering the means by which accuracy in the measurement of crude petroleum and its products may be obtained it will be convenient to outline very briefly the processes normally used in the measurement of oil in normal type storage tanks. Before being placed in service, the tanks have been carefully measured and tables have been prepared showing the volume or capacity corresponding to various oil depths. The depth of the oil in its container is measured by taking the "dip" or "ullage", and then the temperature of the oil at the time the dip or ullage is taken is determined. The volume of oil in the tank corresponding to the dip or ullage is then read off from the "tank table", and, if measurement by volume has been agreed upon, the volume of the oil at some standard temperature is calculated from factors which are usually based on the specific gravity of the oil. If, however, measurement by weight is required, the weight of the oil may be calculated by multiplying the weight per unit volume corresponding to the specific gravity by the number of units of volume of oil in the tank.

METHODS OF OBTAINING ACCURACY IN OIL MEASUREMENT

Accurate Instruments

Since the accuracy of each of the instruments used in the foregoing sequence of operations influences the accuracy of the final figures obtained, these instruments should be purchased from a reliable manufacturer, and should be checked periodically against reliable standards. Appropriate corrections should be made to all readings whenever any difference is known to exist between the standard and the instrument in question. Standard dip tapes and ullage rules should be used in preference to "home-made" wooden dipsticks and ullage sticks, which require treatment to prevent "creep" and are often of doubtful accuracy.

Accurate oil measurement by means of gauge-glasses will not be possible unless the temperature and density of the oil in the gauge-glass is the same as that of the oil in the tank. Gauge fittings should be provided with pipes extending to about 3 to 6 feet into the body of the oil, so that the oil in the glass is drawn from the main bulk, and a series of short glasses is preferred to one long one, in order to reduce errors due to any differences in the oil density at varying depths. The specifications for gauge-glasses and scales which have been laid down by authoritative bodies should be carefully adhered to.

The use of positive displacement meters for oil measurement has greatly increased of late and while the high order of accuracy claimed by some manufacturers on behalf of their meters is almost too good to be true, there is little doubt that a new meter can, by careful adjustment with regard to the type of product, and the use of strainers and an adequate air eliminator, give results which are nearly as accurate as those obtained by normal gauging

methods. The extent to which this initial accuracy can be sustained depends upon satisfactory maintenance and regular calibration. Meters used for barrel and can fillings are usually provided with a temperature compensating device which can be adjusted so as to deliver a constant volume as measured at some standard temperature. One of the objections to meters for oil measurement is that any water which may accidentally pass through the meter is registered as oil.

Accurate Capacity Tables

Any errors in the capacity tables of an oil storage tank will be present in all quantity calculations, and as a result discrepancies will be frequent. If the oil is also measured in tanks either preceding or following a suspected tank, then an undue gain on intake and an undue loss on delivery, or vice-versa, will be shown by the suspected tank. This, of course depends on the correctness of the tables for the tanks preceding or following it. Persistent discrepancies which cannot otherwise be cleared up suggest that the tank table should be adequately checked, and if notable discrepancies are found in the tank table there is a case for recalibration of the tank.

The importance of accurate tank tables cannot be over-emphasized, since the effect of errors tends to be systematic.

Accurate Methods

Accuracy in oil measurement should be of a high standard if the methods used in all phases of measurement procedure have been decided upon after careful consideration. Standardization of methods is desirable, although the view generally held is that official standardization of procedure is only necessary as between opposing interests, such as those of buyer and seller. No measurement procedure is satisfactory if it admits such discrepancies as lead to argument between buyer and seller. Where the services of a referee are utilized, no discrepancy between opposing interest can arise, since the referee's figures for the consignment are accepted. The referee may, however, repeat his measurements in order to be certain of his figures. Standard methods, however, should not be so worded as to set a limit to permissible accuracy. For example, rules for dipping should not lay down that tapes are to be read, say, to the nearest one-tenth of an inch, but should be so worded that the nearest one-tenth of an inch is the lowest accuracy permissible. As far as can be avoided, good methods should not prohibit the use of better.

All instruments should be read as closely as they will allow, and readings should not be rounded off to the nearest graduation. A check reading should always be taken, and the results should be written down at once. Since transfers lead to avoidable losses of volatile components, the present tendency to measure small quantities out of large tanks demands high accuracy in measurement. The accuracy implied when small quantities are delivered out of large tanks, if high percentage errors in delivery quantities are to be avoided, is often greater than that actually obtained, and the custom of being more exact with measurements on large tanks than on small has arisen. In fact, however, the greater throughput of small tanks makes it essential to be as exact with measurements on small tanks as on large.

Gauge glasses should be refilled again and again until a constant reading is obtained, and should not be read when exposed to direct sunshine. The number of samples taken from each tank should be the minimum necessary to give a fair average, the usual practice being to take samples at such intervals in depth that no two adjacent samples will show a difference in specific gravity

greater than some chosen figure. Unnecessary exposure of samples to wind and sun should be avoided, particularly when determining the temperature of samples on tank tops. Hot samples will require special precautions against cooling. The sampling vessel should be refilled once or twice to minimize its effect on the temperature of the final sample, and the temperature should be taken without delay. Accuracy in the determination of temperature is at least as important as accuracy in dipping or in any other oil measuring operation, and considerable care is necessary if a reasonably accurate figure for the average temperature of oil contained in a storage tank is to be recorded. This need for high accuracy in temperature measurement is perhaps best appreciated when it is realized that because of the relatively high coefficient of expansion of aviation spirit, an error of 2° F in temperature measurement affects the resultant volume calculations by 0·13 per cent.

Accurate Calculations

All the time and effort which has been expended on careful procedure will be wasted unless the subsequent calculations are accurate also. At present, measurement of oil by weight is widely favoured, but since measurement of bulk oil volumes is a normal step in the process of measurement by weight, measurement by volume at a standard temperature is less troublesome, and at least no less accurate provided the correct expansion coefficient for the product in question is used. Measurement by volume will normally lessen the number of calculations to be carried out and thus lessen the chances of errors arising from calculation alone. Errors in calculation can arise through the underlying theory being at fault; for instance, when ten times the specific gravity of an oil referred to water at 60° F is taken as being equivalent to the number of pounds per Imperial gallon, the results so calculated are about 0·03 per cent too high in the case of gasolines, and about 0·02 per cent too low in the case of fuel oils. Accurate tables for the conversion of oil volumes to weights are available and should be used in place of this approximation.

Since the instruments used in oil measurement are correct at their calibration temperature, many of the theoretical complexities of oil measurement would disappear if international uniformity in oil measurement could be based on that fact, and the following principles should be followed:

(1) *For each system of measurement a distinct standard temperature should be fixed for oil measurement.*

(2) *All apparatus (calibrated tanks, hydrometers, etc) should be correct at this standard temperature.*

(3) *Standard procedure should correct readings at any temperature to this standard temperature.*

(4) *Both specific gravity and volume reduction tables should be based on the same fundamental coefficients of thermal expansion.*

(5) *Oil weights, when required, should be calculated by multiplying the volume at standard temperature by the weight in air per unit volume corresponding to the specific gravity or density at standard temperature.*

(6) *Specific gravities or densities for weight calculations should be determined at temperatures as near as possible to the relevant tank temperatures.*

The last principle enunciated above will ensure accurate weight measurement even when the tables used are not strictly applicable to the oil measured, and the logical outcome of (2) and (3) is that tables for the correction of oil volumes measured in steel tanks should

include an allowance for steel expansion, and that tables for the correction of specific gravity or density should include an allowance for glass expansion. Another question is the accuracy of the actual calculations themselves. If sufficient accuracy has not been obtained the calculations lose their value whilst accuracy beyond a certain degree is purposeless and leads to unnecessary labour.

Inbuilt Accuracy

Much can be done in the way of obtaining accuracy in oil measurement work by intelligent planning of the layout of installations and depots. The difficulties of assessing quantities of oil contained in pipelines may be reduced by providing a regular and satisfactory slope when the lines are installed. Air vents and draincocks installed at high and low points will assist in verifying whether the line is full or empty. Before valve manifolds are fabricated, provision for the easy insertion and removal of blank flanges will facilitate the isolation of two or more operations which are proceeding concurrently and consequently improve the accuracy of their measurement. Gauge glasses should be installed on the side of the tank which faces away from the sun.

Periodic Checks

The general accuracy of oil measurement work can be checked from time to time by periodic overall checks. Inspectors will carry with them carefully standardized instruments, and gauging personnel will be asked to measure the oil in some suitable tank. Working with his own instruments and the best possible precision, the inspector compares his results in detail with those obtained by the gaugers, searching for the source of any discrepancy that may show itself. The greater the accuracy with which measurements are made, the closer will be the agreement between two independent measurements of the same quantity of oil. However, what is wanted is accuracy, and good agreement is merely one test for this. There are many ways in which good agreement can be obtained without increasing accuracy, or even at the expense of accuracy, and these are obviously undesirable. For example, agreement may be obtained by sacrificing the independence of two measurements. If, for example, the same hydrometer is used in making both measurements, agreement will be improved even if the instrument is wrong, since the same error will be present in both measurements. All important checks should be independent. By using a second gauger, a second dip tape, a second set of samples, another thermometer and hydrometer, and so on, the greatest possible opportunity is given for errors in instruments or procedure to show themselves between the two results. If reasonable agreement is still obtained, the proof that the work has been accurately carried out is much more conclusive than if a much closer agreement is obtained by mere repetition. The most effective way of handling discrepancies is to see that the delivery figures from one tank are compared as soon as possible by some responsible person with the receipts for the tank or tanker to which transfer has taken place. Prompt investigation has a much greater chance of detecting the cause of a discrepancy than any inquiries made after long periods of time have elapsed. An equally important step is to make sure that the cause, once detected, is not again allowed to lead to discrepancies. The importance of explaining a particular discrepancy is often very small as compared with the importance of preventing similar discrepancies in the future. If the cause of a shortage cannot be definitely traced to errors in measurement, then the shortage must be due to real loss, and this is a serious matter.

EFFECTS OF ERRORS

Errors in measurement fall into two main types—fortuitous errors and systematic errors. Fortuitous errors include sheer mistakes but consist mainly of the inevitable small errors of observation. No method can exclude sheer mistakes, and since really fortuitous errors tend to cancel out in effect in a long series, much higher limits may be tolerated for these errors than for systematic errors. The effect of fortuitous errors is that two independent measurements of the same quantity of oil will not in general lead to the same figures, as a result of differences in these errors between the two measurements. Only rarely will the extreme case arise in which all fortuitous errors tend in one direction in one of the measurements, and in the opposite direction in the other. If a method is such that discrepancies of a given percentage are very infrequent, then more than half the pairs of measurements may be expected to agree within a quarter or a fifth of that percentage. Any standard method should sufficiently state the limiting conditions, say, of oil temperature, volatility and the like, under which it is applicable, since these are factors limiting error. Systematic errors, which most frequently arise from faults in instruments, affect all measurements in the same sense, and do not cancel out in long series. The limit of tolerance for this type of error cannot be settled from considerations of fortuitous errors. Errors in oil measurement follow the usual mathematical theory of errors, and given a sufficient number of cases it is possible to separate the effect of systematic errors from that of fortuitous errors. The latter are distributed normally, small errors being much more frequent than large.

STOCK ACCOUNTING

From the time the crude oil issues from the well right to the delivery of finished products to customers, a record is kept in the oil company's accounts, and measurements are made at all stages. Detailed records of these measurements are kept, and accurate measurements at all points is desirable. Not only is it essential to know the actual stock in an installation or depot at any time, but when blending operations are carried out it is essential that the correct predetermined amounts of the component parts of the blend are delivered into the blending tank.

It is usual to make a complete inventory of stocks at regular intervals, and sometimes official regulations may require that a periodic stock statement be issued. Accurate stocktaking must depend upon accurate gauging of the oil in the tanks and accurate assessment of quantities contained in pipelines. Irregular tank bottoms always present a difficulty, and if the product contained in the tank will not permit a water bottom to be carried, the tank bottom must be accurately calibrated. Tanks with floating roofs present an obstacle to accurate stocktaking which is normally avoided when transfers and other stock movements are made by ensuring that the roof is in the same position relative to the oil before and after the movement.

Where a long series of operations is involved, a check of the stocks at some intermediate point will often yield valuable information as to the accuracy of the measurements. The increasing use of additives for special purposes also necessitates having accurate knowledge of the stock of oil in particular tanks.

FINANCIAL ACCOUNTING

The financial side of oil accountancy is naturally very important, and increasing oil values are making it more necessary than ever to be accurate in the measurements upon which the financial transactions are based. Royalty payments have often to be made on oil produced in the fields, or on oil put through some specified refining process or plant.

and the government or company receiving the royalties will need to be satisfied as to the accuracy of the measurements made.

The charges made for the transportation of oil by water, road, or rail are usually based on weight. In the case of tanker and barge freights, the payment is based upon an oil volume which has been converted to a weight, and accurate determinations of the specific gravity and temperature of the consignment are required. Charges to the consumer are based on the assumption that the figures for the amount of oil debited to him are as accurate as is possible. Should these figures not be reasonably accurate, complaints of shortages will occur, and custom may be lost.

Where bulk purchases or sales are concerned it is usually agreed that payments are based on the measurements made at one end or the other, but measurements are made at both ends to discover whether there has been any loss in transit. Those making the payment will require to be satisfied that the quantity charged for has been received, while those receiving payment will primarily wish to know that the quantity specified has neither been exceeded nor been under-delivered.

Storage charges are made in cases where the oil does not belong to the same company as the tanks themselves, or there may be an undertaking by one party to import, refine, blend and store oil on behalf of another. Accurate measurement at all stages will account for any losses which may have taken place and ensure satisfaction all round.

Where oil products are dutiable, accurate measurement minimizes the risk of dispute between the customs authorities and the oil company. Dutiable oil is usually under bond and the duty paid on all quantities taken out of the bonded area. There must be agreement between quantities, any differences being satisfactorily accounted for.

CONTROL OF LOSSES

Losses may be divided into two kinds, real and unreal. Real losses occur through actual leakage due to accidents, through evaporation of light fractions during handling and storage, and occasionally through theft; whilst unreal losses are due entirely to errors in measurement. Obviously these errors in measurement obscure the real loss figures, and the first problem met with in loss control is the separation of real from unreal losses.

Statistical methods of analysis will reveal the points between which the losses are apparently taking place and the amount of these losses. Apparent losses through errors of measurement at any stage will tend to reappear as gains at the next or the preceding stage, while real losses will not show any such tendency. This, of course, does not apply to errors at the last point of measurement before sales; here, errors in measurement are equal in importance to real losses.

After the place of occurrence of real loss has been sufficiently determined, and the causes which account for the amount of the loss have been observed, methods of reducing the amount of the loss should be devised.

When a loss, previously larger, has been substantially reduced, all that need be done regarding the small residual loss is to check from time to time that it does not grow larger.

It follows then, that in order to control and reduce losses, a comprehensive study of all the operations involved in the storage, transport and distribution of the oil must be made. If necessary a carefully prepared programme for training oil measurement personnel should be carried out before improved methods are developed. The reduction of apparent losses due to errors in measurement is usually a rapid process, since one cause often affects several cases, and the process of reduction of physical

losses should be carried on until losses have been reduced so far that it costs more than they are worth to reduce them further.

CONCLUSION

Much effort has been expended towards obtaining one system of weights and measures throughout the world, and although this ideal position has not been attained, in oil measurement matters the trend of satisfactory progress towards international standardization is reflected by the increasingly active and close co-operation between the various national standardizing bodies. In 1944 the A.S.T.M. and the I.P. published "Principles Governing Oil Measurement Procedure", a document which had been agreed by the two bodies.

Desirable as it would be for simplicity and uniformity, experience has shown that there are many difficulties associated with attempts to lay down a single method of oil measurement for adoption throughout the world. Where the oils handled are relatively uniform, in temperature and otherwise, methods of measurement can be simplified to a degree that would be quite unsatisfactory where greater irregularity is present. Mechanical adoption of any particular method can lead either to greater elaboration than is necessary, with consequent waste of time and money, or to too great a simplification, with consequent loss of accuracy and adequate control on working. Study from this point of view of the methods in use will often be repaid, and the importance of a high degree of accuracy in all work cannot be too strongly emphasized. No simple precaution which tends to improve the accuracy of the operations involved in oil measurement should be omitted.

It has been suggested from time to time that procedure and methods for measuring petroleum and its products have remained more or less static for many years, but in spite of the apparent static state, improvements are continually being sought. The fact that the old methods have remained in satisfactory use for so long says much for them.

UTILIZATION OF PEAT

It is estimated that approximately 1000 million tons of air-dried peat could be made available in Great Britain, states a report on "The Winning, Harvesting and Utilization of Peat,"* recently issued by the Fuel Research Station of the Department of Scientific and Industrial Research.

The use of peat as a domestic fuel and for steam generation are dealt with. From the point of view of carbonization tests have been made in the Gray-King carbonization assay apparatus, but it is considered that there is little chance of economic success for peat carbonization in Great Britain.

By the extraction of certain types of peat with solvents, ester waxes can be obtained which, by suitable treatment, may prove satisfactory as a substitute for montan wax. The report concludes that from the information at present available it would appear that the extraction of waxes from peat is a possible method of utilization which should be carefully studied.

* H.M.S.O. 6d. net.

BRITISH TAR CONFEDERATION

Officers of the British Tar Confederation elected for the year 1948 are Dr T. Howard Butler, J.P. (*President*); C. E. Carey (*Hon. Treasurer*); R. Alsop, C.B.E. (*Chairman of Executive Board*); Dr E. V. Evans, O.B.E., and S. Billbrough (*Vice-Chairmen of Executive Board*).

STANLOW BRANCH NOTES

At a meeting of the Stanlow Branch held at Thornton Research Centre on December 16, 1947, Mr L. Rosenfeld and Mr J. C. McNicol read a paper, previously presented before the Institute in London, entitled, "Examination of Used Engine Oils." The lecture was followed by a lively debate which brought out the varying view-points of the engineer, the chemist and the technical sales expert.

The Branches Committee held their December meeting at Stanlow on December 17, and members of the committee and their ladies were guests at the second annual dance which was held in Chester in the evening. The committee were entertained to lunch and dinner on this occasion by "Shell" Refining & Marketing Co. Ltd, on behalf of the Stanlow Branch.

The Annual General Meeting was held on January 28. The chairman reported on the activities of the Branch and the balance sheet was presented and adopted. In accordance with the rules, three members were elected to fill vacancies on the committee. The members elected were Messrs J. S. Parker, A. B. Robins and W. T. T. Wilcox. The new committee, which does not take office until April, will now include two non-corporate members in the persons of Mr Robins and Mr Wilcox.

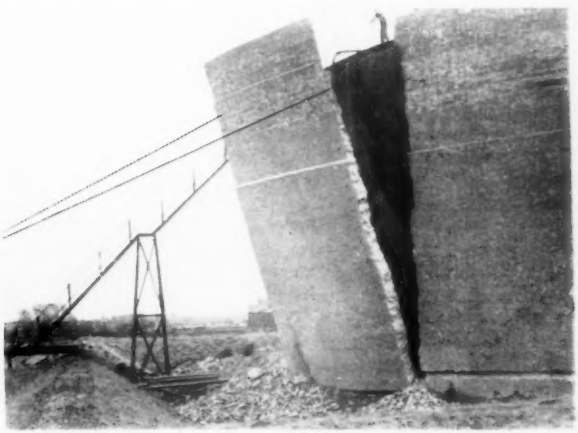
Mr F. Brice and Mr J. H. Tripp were re-elected honorary auditors.

At the conclusion of the business of the Annual General Meeting, Mr E. Thornton gave an instructive and entertaining talk on "Oil Fires" which was followed by the usual informal discussion.

Present membership of the Stanlow Branch is 57 corporate and 64 non-corporate members but there is evidence that membership in both categories will be increased in the near future.

The annual subscription for non-corporate members of the branch now covers subscription to the *I.P. Review* which will therefore be received by all members whose subscriptions are not in arrear.

BLAST WALL DEMOLITION

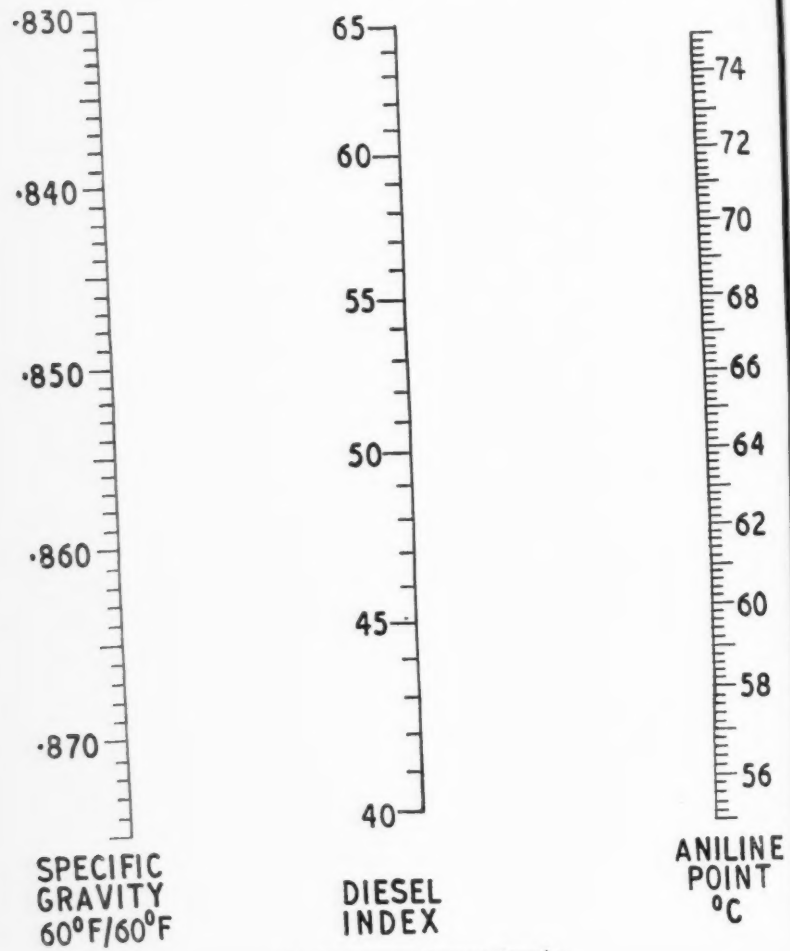


We are indebted to Mr Jas. S. Parker for this photograph of a method for the demolition of blast protection walls when these are built away from the tank. By means of air tools two vertical rips and an undercut are made. A cable is then passed around the section and attached to a tractor. The result is shown in the picture.

DIESEL INDEX CALCULATIONS SIMPLIFIED

By H. E. STYLES*

The Diesel Index (I.P. 21/42) being derived from the product of A.P.I. gravity and aniline point in degrees Fahrenheit can readily be determined graphically by means of a nomogram in which the outer scales are logarithmically divided in terms of A.P.I. gravity and aniline point °F respectively, the



* London Passenger Transport Executive.

centre scale, also logarithmic, being appropriately divided in terms of Diesel Index.

If the outer scales of such a nomogram are recalibrated in terms of specific gravity and aniline point °C, the conversion of these two characteristics to A.P.I. gravity and aniline point °F is avoided. Such a nomogram is illustrated here and from this the Diesel Index may be determined directly from the values of specific gravity and aniline point °C.

To use this nomogram it is merely necessary to join the appropriate values of specific gravity and aniline point by a straight line which will intersect the centre scale at the appropriate value of Diesel Index.

OIL BURNING ON MAIN LINE STEAM LOCOMOTIVES

At their meeting on January 30, 1948, the Scottish Branch of the Institute were addressed by Colonel W. L. Topham, O.B.E., assistant to the general manager of The Vulcan Foundry Ltd, who spoke on "Oil Burning on Main Line Steam Locomotives."

Introducing the lecturer, the Chairman (Mr Robert Crichton) said that Col Topham had spent fourteen years in various appointments with the Buenos Aires & Great Southern Railway. During the war he was seconded as assistant and chief mechanical engineer with the Egyptian State Railways and became deputy director of mechanical transport. Latterly he was Colonel in Charge of Railway Mechanical Engineering in Italy and the Central Mediterranean Forces.

During the course of his address, which was illustrated with lantern slides, the lecturer outlined the early history of oil burning, in Russia and the western United States during 1890, and in Great Britain, on the Great Eastern Railway, in 1891. He traced its progress up to the present day, when it is usual in the western and southern U.S., on most Argentine Railways and in many of the other South American countries, in Iran, Egypt, Iraq, Palestine and Syria. The world shortage of coal caused by the war obliged many railways to convert to oil, and consequently the subject is of special interest in many countries at the present time.

Colonel Topham dealt in detail with the economics of the coal versus oil question, emphasizing the advantages of the latter in longer runs without refuelling, quicker turn-around of engines, cleanliness, reduction of operating costs through elimination of coal and ash handling, fewer running shed staff, ease of transport handling and storing, elimination of coal and firewood storage losses, flexibility of firing, absence of sparks, and quicker steaming from cold.

Supply arrangements and general layouts in the Argentine and Egypt, with which the lecturer is particularly familiar, were described, as well as apparatus used on various railways to achieve the greatest possible efficiency. Colonel Topham also gave a number of useful hints on the effects of oil burning on boilers, mechanical considerations, steam raising, running operations, and consumption.

Over 70 were present at the meeting, the audience including members of the Scottish Section of the Institution of Locomotive Engineers. Votes of thanks to the lecturer and to the chairman were proposed by Messrs H. McArthur and D. Miller respectively.

The **Horton Lifter Roof** is the subject of Bulletin C just issued by the Chicago Bridge & Iron Co. The bulletin describes the method of determining the size of roof required for any set of conditions and also the design of vapour lines.

ENGINE LUBRICATION AND THE LAW

By V. BISKE (Fellow)

"If the law supposes that, the law is a ass" (*per* Mr Bumble, C. Dickens, *Oliver Twist*, Chap. li).

THE driver of a motor vehicle on the roads of Britain has long been accustomed to being directed as to the manner in which he shall drive his car or motor bicycle and, recently, as to whether he shall drive it at all, and if so, where. It may however not have occurred to him that the manner in which he shall lubricate his engine is, according to the latest enactment, also a matter in which his liberty of action is, if he wishes to avoid any risk of unpleasant consequences, restricted. This, it is submitted, is the effect of certain clauses of Statutory Rule and Order No. 2058 of 1947 (The Control of Motor Fuel Order, 1947).

This order, which is the one abolishing the "basic" ration of petrol, also re-enacts the prohibition of the use of "kerosene" for supplying motive power to any vehicle, except under the authority of a licence. This prohibition is of course in addition to the prohibition contained in the Finance Act, 1935, Sect. 2 of the use of heavy oils (unless these have paid the full rate of duty) in road vehicles. "Kerosene" (which expression is stated to include paraffin oil, burning oil, vaporizing oil and white spirit) is defined as being a hydrocarbon oil with a flash-point in excess of 73°F and below 150°F when tested by the methods specified in the Order. (Incidentally, as the Order specifies the appropriate I.P. test methods, it might be consistent and adopt the Institute's spelling for kerosine.)

Having thus defined kerosine, the Order then proceeds to state that "hydrocarbon oil shall be deemed to contain kerosene" if, having an Abel flash-point of below 73°F, its "maximum temperature of distillation" (when tested by I.P. method No. 28/42) is above 215°C.

Such an assumption is not new, having been included in a previous Order controlling motor fuel (S.R.O. No. 2400 of 1942), made under the Defence (General) Regulations, 1939. It should however be pointed out that, firstly, such a method for the determination of "kerosene" (as defined in the Order) is only of limited applicability, since it will obviously not show the presence of white spirit, the use of which is banned equally with that of "paraffin oil", and that, secondly, it could, if strictly enforced, cause grave injustice to those motorists who either mix a small amount of lubricating oil with their petrol in order to act as an upper cylinder lubricant, or who, operating two-stroke motor-cycles, are forced by the design of the lubricating system to run their engines on petrol/oil mixtures.

The maximum specified final boiling-point of motor spirit to the present "Pool" specification is 205°C, thus allowing a 10°C gap before the legal maximum of 215°C mentioned above is reached. Whilst such an interval is adequate to allow for variations in testing and to give some latitude to deliveries verging on the specification maximum, it does not take into account the rise in final boiling-point of gasoline caused by the admixture of even a small amount of lubricating oil.

The average distillation figures in Table I, all carried out according to method I.P. 28/42, bear out this contention.

It will be seen that even the presence of 1 per cent of a thin lubricating oil, such as is used for upper cylinder lubrication, raises the final boiling-point of the motor spirit by 20°, whilst a mixture of 10 per cent of a medium viscosity engine oil with 90 per cent of motor spirit (and most engines operating on

TABLE I

	Increase (°C) of reading over corresponding figure for sample of "Pool" motor spirit used for the tests.		
	Blend "A"	*Blend "B"*	*Blend "C"*
Temp. for 70% dist. °C	2	10	9
,, 80% ,,	3	17	13
,, 90% ,,	3	47	18
F.B.P. ,,	20	100+	44

Blend "A" = Pool Motor Spirit + 1% of light lubricating oil (Pool 3).
Blend "B" = Pool Motor Spirit + 10% of medium lubricating oil (Pool 12b).
Blend "C" = Pool Motor Spirit + 10% of kerosine.

petrol/oil mixtures require a somewhat larger proportion of oil) causes the maximum distillation temperature to be raised by about 100°. Thus in each case the figure obtained on these mixtures, which are typical of what may be found in the tanks of motor vehicles operated in a perfectly normal and hitherto lawful manner, is one which, according to the regulation, would presuppose the presence of kerosine.

It will be seen from the last column that the presence of even as little as 10 per cent of kerosine (and it could hardly be assumed that anyone wishing to burn this fuel illegally would trouble to make a blend containing a smaller proportion) has a marked effect on the distillation characteristics of the resultant mixture, and it is considered that the presence of any appreciable proportion of kerosine in motor spirit could quite adequately be determined by a competent analyst from an inspection of the distillation curve, coupled if necessary with other tests. The fact that the major component of any suspected blend would be Pool motor spirit, which is a more or less uniform material issued to a specification applicable throughout the whole country, would considerably facilitate the task of determining the presence of any illegal adulterant.

Even if it is considered that the final boiling-point is a factor of major importance in detecting kerosine in such circumstances, it is submitted that, instead of the fact that a maximum temperature of distillation of 215°C has been exceeded in the standard test creating an irrebuttable presumption of the presence of kerosine (or, more accurately, instead of such a fact being a rule of substantive law stating that kerosine *is* present) a fairer course would be for the regulation to contain the words "until the contrary is proved" after the words "Hydrocarbon oil shall" at the beginning of clause 25 of the Order. The inclusion of such a term, which places the onus of proof of non-transgression of the Order on the defendant, is a practice which is in line with numerous statutes in which the phrase "shall be deemed" is to be found.[1]

The view that a mixture of lubricating oil and motor spirit would be held to contain kerosine if it infringed the test laid down in the Order is supported by the definition of "deemed" given by Cave, J., in *R.* v. *Norfolk County Council*, (1891) 60 L.J. (Q.B.) 370, at p. 380:

> Generally speaking, when you talk of a thing being deemed to be something, you do not mean to say that it is that which it is deemed to be. It is rather an admission that it is not what it is deemed to be, and that, notwithstanding it is not that particular thing, nevertheless, for the purposes of the Act, it is deemed to be that thing.[2]

Moreover, even though the Court might be aware that kerosine had in fact not been used, it might feel that it was bound by the literal wording of the Order to consider that an offence had been committed; this view is supported by authority if we consider the words of Lord Halsbury, L.C., in *Shepheard* v. *Broome*, (1904) A.C. 342, at p. 345.

> It is a painful duty to be obliged to treat that as fraudulent which in truth was not fraudulent but . . . (the Act) . . . compels us to say that it shall be deemed to be fraudulent.

As far as the writer is aware, no case on clause 25 of the present Order (or on similar clauses in earlier Orders) has been reported. It is possible that in any proceedings arising from the use of a

motor spirit containing lubricating oil, and where the final boiling-point of the mixture was above 215°C, it would be open to the defendant to argue that, whatever the "final boiling-point" observed was, this was not the "maximum temperature of distillation", which latter is the actual wording used in the Order. It is specified in the Order that I.P. method 28/42 shall be used for determining the "maximum temperature of distillation", when the flash-point of the mixture is below 73°F. In this method the phrase "maximum temperature of distillation" does not occur, the final boiling-point being defined as "the maximum temperature observed on the distillation thermometer" and it is added that this is usually reached after the bottom of the flask has become dry, and that if the bottom is not dry, this fact shall be recorded.

It could thus, possibly, be held that the "maximum temperature of distillation" is the maximum temperature reached whilst distillation is proceeding, and is not the same thing as "the maximum temperature observed on the distillation thermometer", which, in the case when lubricating oil is present, is reached after the distillation has, as observed by eye, virtually ceased.

Such an interpretation, whilst admittedly doubtful, might be accepted, and, on the question whether such a mixture was "deemed" to contain kerosine some light could be obtained from an Australian decision, *Muller* v. *Dalgety & Co. Ltd.*, (1909), 9 C.L.R. 693, where Griffith, C. J., observed in considering the meaning of the word "deemed":

> It creates a statutory fiction for the purpose of extending the meaning of some term to a subject matter which it does not properly designate. When used in that sense, it becomes very important to consider the purpose for which the statutory fiction is introduced.[2]

The significance of the last sentence in this quotation is evident in a case such as we are at present discussing.

In considering how the Court would interpret clause 25 of the Order under discussion it should be borne in mind that the Order imposes a penalty, and hence, if there were two reasonable interpretations to be placed on the words in it, that meaning which was in favour of the defendant might tend to be taken by the Court. In a case heard during the last war and concerning a breach of a Defence Regulation governing the use of motor fuel Viscount Caldecote, C. J., observed "it must be remembered that the provision is a penal one and must be construed strictly".[3]

However, such a somewhat doubtful loophole should not be necessary since, as mentioned above, the inclusion of the words "until the contrary is proved" would enable a *bona fide* defendant to produce evidence that a high final boiling-point was not necessarily due to the presence of "kerosene".

It may be objected that even such a relaxation runs counter to the common law rule that "the presumption of law is that a person accused of any crime is innocent"[4] but it must be recognized that this presumption is more and more being whittled away by statutory exceptions[5] and that, with the increasing complexity of modern society, such exceptions are inevitable if justice is to be done.

The safe course for the motorist would thus appear to be, if one may parody G. K. Chesterton, "I don't care where the oil goes if it doesn't get into the petrol".

REFERENCES.

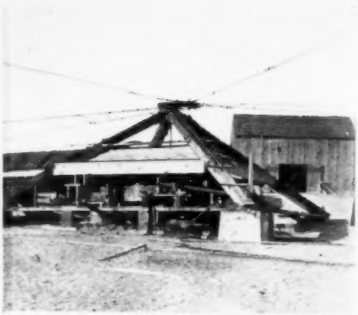
(1) e.g. Factories Act, 1937, sect. 142; Companies Act, 1929, sect. 120, (3); Bankruptcy Act, 1914, sect. 138, (2).

(2) As quoted by Magnus and Estrin in *The Companies Act, 1947* at p. 61."

(3) *Smith* v. *Barkley*, 60 T.L.R. 78 at p. 80.

(4) Harris, *Principles and Practice of the Criminal Law*, 17th edn., at p. 474.

(5) e.g. Finance Act, 1934, sect. 16, (2).



THEN AND NOW

In the early days of the petroleum industry oil wells which needed pumping for production were operated in groups from a central power (left, above). *A band wheel in the lower part of the structure was driven from a suitable engine and was provided with an eccentric above the apex of the pyramid. To the periphery of the eccentric were attached lines (jerker lines) which conveyed the reciprocating motion to the well-head equipment, one pattern of which is shown on the right above. Here the horizontal motion was converted to a vertical motion to operate the pump in the well.*

To-day, similar but vastly improved equipment is seen in use in production of oil from small producers but it is not uncommon for such wells to be pumped by a complete unit. Such a unit is seen below, where the prime mover is an electric motor operating the pump through a walking-beam.

ECONOMY OF A ROADWAY SYSTEM

An Address by

C. T. BRUNNER (Fellow)

to the Oil Industries Club

THE reason why I should be invited to the Oil Industries Club to talk about roads is that a very large proportion of the oil industry's livelihood is derived from fuelling road vehicles and from providing road construction materials, while a great deal of oil transport and delivery is made by road. The prosperity of oil is so closely linked with the roads and road traffic that it seems right and reasonable that the oil industry should take a special interest in all road matters.

To-day our roads are inefficient and out-of-date, inadequate for their burden of traffic. Even now that the basic petrol ration has been abolished, traffic congestion is all too common a sight. What, then, can be expected when the number of vehicles on the roads again increases? It will only be possible to accommodate the traffic of the future by modernizing the road system; this will include both the building of new roads and the improvement of old.

PLANS FOR IMPROVING THE ROAD SYSTEM

There is no secret about what is needed. The Government—eighteen months ago—announced a ten-year road development plan; this provided, amongst other things, for a suspension bridge spanning the Severn (shortening the road distance between Bristol and South Wales by fifty miles); a tunnel at Jarrow linking Durham and Northumberland; a Thames tunnel between Dartford and Purfleet; and the building of 800 miles of motorways, that is, roads reserved exclusively for the use of motor traffic.

There was disappointment in the early part of 1947, when the Government decided to curtail grants to highway authorities for what might be termed routine road expenditure. Now a very large cut is to be made in capital construction programmes. New road works will be reduced considerably, and major undertakings are to be postponed. The present position therefore is that, although plans for securing an efficient road system have been to a large extent finalized, their execution has been put off more or less indefinitely. So far from agreeing that we cannot afford to build better roads, my thesis is that we cannot afford not to build them. A good road system is one of the best investments Great Britain can make.

THE ECONOMIC APPROACH TO THE ROADS

I am not a highway engineer, but I have been interested in roads for a long time as an economist, and it is from that point of view I want to approach the subject. Roads are of course one of the most important economic assets belonging to the nation. They are even more than that, since a good road system has many non-economic values; it contributes to the social amenities of life and in particular it may have a great strategic value.

As a matter of fact, a very large part of road construction has always been undertaken for strategic and police reasons, rather than for commercial purposes. Examples are the Roman roads in Britain, and on the Continent, the network of roads built by the Incas in Peru, Napoleon's *routes nationales* in France, and the roads built in Scotland by General Wade in the second quarter of the eighteenth century as part of the plan for the pacification of the Highlands; I am not sure that the roads

Telford built in the Highlands in the first quarter of the nineteenth century did not have a similar purpose; more recent strategic roads have been the German *autobahnen*, the north-south road built in Australia during the war, and the Alaska Highway. However, I am not proposing to deal with the non-economic values of roads, but to consider the British road system essentially from an economic point of view, and to try to suggest the extent to which its further development would be economically advantageous.

If one isolates the economic factors relating to the roads, the fundamental principle should be that any project for road construction or improvement should result in a net saving of money to road users as a whole. In other words, there is no reason why the same yardstick should not be applied to expenditure on roads as to any other form of expenditure—will it pay? For the sake of simplicity, it is convenient to relate this question solely to mechanically-propelled vehicles, and to consider the road purely as a track for mechanically-propelled vehicles. This is, admittedly, only one aspect of roads, but it does have the advantage of making it at any rate theoretically possible to put forward a statistical estimate of expenditure on road works and of consequent saving in vehicle operating costs.

Now, to forestall a possible criticism of this method of approach to the road question; it is, of course, not only necessary to show that £1 spent on road improvement will save more than £1 on vehicle operating costs, but ideally also to show that £1 spent on roads will give a bigger return than £1 spent on something else, such as a new power station. It is a question of making the best use of scarce resources. The development of the national resources must not be allowed to become lopsided. A combination of a perfect road system with obsolete industrial equipment would be just as stupid as a drive to improve the level of industrial equipment and housing while neglecting the roads.

THE PROPER SIZE AND TIMING OF ROAD EXPENDITURE

Improvement must keep in step on all fronts, and the real problem is to determine how much of the national resources can properly and economically, at this stage of development, be earmarked for the improvement of the road system. My aim is to provide an approach for determining to what extent an increased expenditure of the national resources on the improvement of the road system would be economically justified. I do not claim to be able to put forward a technique for

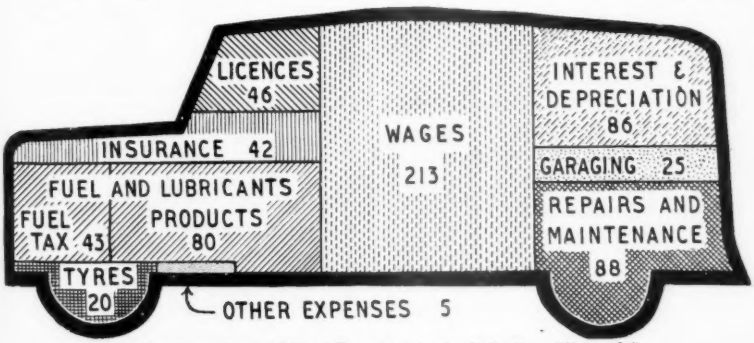


Fig. 1.—Annual cost of Road Transport in the U.K. (in millions of £).

determining exactly when such expenditure should be embarked upon. One school of thought would hold up capital development works to be undertaken in times of trade recession, with a view to maintaining at all times a steady level of employment.

Last year British motor-users spent nearly £650,000,000, equal to 1*s.* 6*d.* in the £ of the whole national income, in operating mechanically-propelled vehicles on the roads. The break-down of this figure under the different heads is shown in Fig. 1. Several of these items are very directly related to the standard of excellence or otherwise of the road system.

The wages cost reflects traffic delays and unduly low speeds; expenditure on maintenance and repairs, fuel and tyres is closely dependent on the road system; the cost of insurance is a function of the number and gravity of road accidents and these in turn are largely a reflection of the excellence or otherwise of the road system. In order to put things in a proper perspective, the cost to-day of maintaining and improving our roads on the scale that this was being done before the war would be about £110,000,000 a year.

The thesis I am putting forward is that it is worth while to spend more on the improvement of the road system, so long as there is an even bigger saving in the cost of operating road vehicles, resulting from economies which are made possible by the improvement in the roads, in fuel, tyres, wear and tear, and delays. It would in fact be reasonable to increase the rate of expenditure on the roads so long as such increases did not involve an overall increase in the public's expenditure on road transport. It follows from this that, the bigger the traffic the roads are called upon to carry, the stronger is the case for spending money to provide better roads.

This method of approach is of course equally applicable in considering the improvement of a particular road or of a particular road junction or bottleneck. In certain states in the United States, such as Oregon, a great deal has been done on these lines of recent years, and it is now a standard requirement that, when any scheme for improving a road is put forward, a kind of balance sheet is drawn up, offsetting the estimated economies to be effected by the improvement, in the way for instance of saving time for traffic using the road, against the cost of the improvement.

This system has the effect of greatly strengthening the hands of the highway authorities who, by employing it, are put in a position to devote the funds they have available to the most useful of the jobs waiting to be done, and to deal with any criticisms they may receive for doing some work or for not doing something else. The method provides an automatic check on extravagance, and wasteful expenditure while at the same time ensuring that, where it is supported by the figures, justifiable development work is put in hand.

A great deal of research work has been done, mainly in the United States and almost all of it outside Great Britain, in assessing the extent of the waste in various directions which arises from an inadequate road system. By far the most important waste, looked at purely in terms of the money involved is waste of time through traffic congestion and delays resulting in unduly low point-to-point speeds. This falls naturally into two parts; first, waste of time in built-up areas, and, secondly, waste of time on roads outside built-up areas.

FACTORS RESTRICTING SPEED ON URBAN ROADS

So far as urban areas are concerned, the factors restricting speeds are (1) traffic lights and controls, (2) overnumerous street junctions, (3) obstacles blocking the road, (4) friction resulting from slower-moving vehicles and pedestrians, and (5) restricted vision of the

road ahead. It has been suggested that 20 m.p.h. would be a reasonable urban point-to-point speed at which to aim; this is, however, probably too high for the inner areas of European cities, and 15 m.p.h. might be a more reasonable target. Even this would represent an enormous improvement on present-day standards.

Most of the research work is, as usual, transatlantic, but it was found that in Boston, a city of 800,000 population, the average traffic speed in the inner areas was 8½ m.p.h., falling to 4½ m.p.h. in the business districts during hours of congestion. In addition to low speeds, parking vehicles may involve great waste of time. In Washington, D.C., it was found that an average speed of a car of 14 m.p.h. from the suburbs to the centre, was reduced to 9·9. m.p.h. by the time spent in finding a parking place, and to 7·3 m.p.h. by the time spent walking from the parking place to the actual destination.

The present-day approach to the urban street problem is to canalize traffic movement so far as possible along recognized traffic routes; on these routes, to replace traffic lights and controls by fly-over junctions, roundabouts, and other devices enabling non-stop movement to be maintained; to seal off side streets, apart from the foot-paths, where feasible, and to prevent vehicles being parked or left stationary on traffic routes. By these methods it should be possible to increase average point-to-point urban speeds by 25 per cent, while still leaving them well within the assumed reasonable average of 15 m.p.h. in inner areas, and 20 m.p.h. in outer areas.

FACTORS RESTRICTING SPEEDS OUTSIDE BUILT-UP AREAS

Outside the built-up areas, the problem of waste of time is rather different in its nature, although the principles are the same. Again, we must look to the United States, where vehicles are higher-powered in relation to their weight than here, and to pre-war Germany, for the bulk of the research. American research indicates that actual average point-to-point speeds outside built-up areas, on roads of normal traffic density, are about 30 m.p.h. for cars and 24 m.p.h. for commercial vehicles; on the newer roads, where traffic conditions are easier, these figures rise to about 40 m.p.h. and 34 m.p.h. respectively. Plans have been made for a system of inter-regional highways, which will be designed for safe speeds, outside built-up areas, of 75 m.p.h. for passenger cars, and 60 m.p.h. for goods vehicles. The principle is again to canalize long-distance and fast traffic wherever possible on to special motor roads—in Britain yet to be built, although plans are well advanced. A Motorways Bill has been drafted, but its future, in view of cuts to be made in the capital construction programme, must be considered uncertain.

In Britain it might be reasonable to be somewhat more modest in objectives, than in the United States and to suggest that an average point-to-point speed of 50 m.p.h. on motorways, of perhaps 35 m.p.h. on trunk roads outside built-up areas, and of 30 m.p.h. on lesser traffic routes, would be reasonable as targets, although a 10 per cent improvement over current levels could be attained without even approaching these figures. Present schedule speeds in Britain outside the towns are based on about 15 m.p.h. for omnibuses, 16 m.p.h. for heavy goods vehicles and 24 m.p.h. for light goods vehicles; there is not much information about British car speeds, but, on average, cars are probably slightly faster than light goods vehicles. Taking town and country roads together, it would be not unreasonable to aim at an average increase of 15 per cent in point-to-point speeds, made up of 25 per cent improvement on urban roads and 10 per cent on

roads outside built-up areas. Such an improvement should be well within the capacity of a reasonably modest programme of road improvement.

VALUE OF SAVING OF TIME

It is not impossible to make an assessment of the value of such a saving. It has been estimated that in 1946 motor vehicles spent 900 million vehicle-hours a year on the roads, and that the value of time saved would be in the order of 3*s* 6*d* or more, per vehicle-hour, according to the type of vehicle; the saving which would result from a 15 per cent increase in overall speeds would represent a total of about £26,000,000 a year. This is the cost to the country of the delays arising from inadequacies of the road system, which could be eliminated if a reasonable modernization programme were undertaken. £26,000,000 would represent the value of the saving of time only, irrespective of any parallel saving there might be in fuel consumption, tyre wear and tear, cost of vehicle maintenance and repair, or lower incidence of traffic accidents.

As a matter of fact there is good reason for supposing that the public puts a higher value on saving in time than is suggested by the figures given above of 3*s*. 6*d*. an hour and upwards. At any rate it has been found in practice that people are willing to pay quite substantial sums for the use of toll bridges and ferries, and it would seem that their principal, if not their only, motive in so doing is to save time. It is more difficult to assess the value which people using public transport in their own time, as distinct from time for which they are being paid, would place on a speeding up of schedules; no attempt has been made, nor, I think, can be made, to assess this factor, but it is probably by no means negligible, perhaps especially in the matter of journeys to and from work.

SAVING IN FUEL

The saving of fuel, which would follow from a modernized road system, is perhaps the second biggest potential economy. This subject can be approached from several angles. To the extent that long-distance traffic can be diverted to new motor roads, both American and German experience agree that the saving in fuel amounts to between 35 and 40 per cent, if vehicles travel at the same speed on the new roads as on the old; of course, if they travel faster, as they usually do, the saving in fuel is less, up to the point where, if they travel twice as fast on the new road as on the old, there is no saving of fuel at all. The motorist, in fact, has the alternative of either saving time or saving fuel, and in most cases he prefers to save time.

In built-up areas, on the other hand, there is scope for a great saving if traffic can be made to flow more smoothly. Experiments in Iowa show that as much fuel is consumed by an undesired stop at 35 m.p.h. as by 0·15 miles of ordinary running, while, with commercial vehicles, it has been found that the consumption in third gear is 50 per cent higher than in top, and the consumption in second gear twice as high as in top. In city areas, low gear work appears to occupy about one-third of the time a vehicle is actually moving. In addition, there is the waste of fuel when a vehicle is held up stationary, and the engine is idling.

The total motor fuel bill in 1946 was in the order of £123,000,000 and it is thought that, with a reasonably adequate road system, it would not be too much to look for a 10 per cent economy under this head, say something like £12,000,000 a year. Estimates of this kind can, of course, only be in the nature of intelligent guess-work when applied to the road system as a whole rather than to a particular road, but there is, at any rate, enough information available to enable

targets to be put forward which should not be wildly outside the range of what is possible.

COST OF ROAD ACCIDENTS

Perhaps the third biggest waste deriving from an inadequate road system, primarily constructed to cater for the needs of horse-drawn vehicles, is road accidents. Something like £50,000,000 a year is spent in insurance against road accidents, and experience where the problem of road accidents has been scientifically approached would suggest that a reduction of 20 to 25 per cent in their incidence, equivalent to a saving of £10,000,000 a year in insurance charges, would be a very modest target at which to aim. The research on this subject is at any rate most encouraging.

The Oxfordshire County Highways Committee found, as a result of investigation over a three-year period before the war, that 59 per cent of the accidents on the roads under its supervision could have been prevented by the removal of ordinary road defects. Experience in Connecticut shows reductions in accidents at numerous traffic junctions and other dangerous places, of 14 per cent following the introduction of traffic lights, of 33 per cent following the display of warning signs, and of 47 per cent following the construction of roundabouts. Dual carriageways would appear almost to halve accidents, and the lighting of unlighted roads to reduce night-time accidents by up to 75 per cent. New motor roads have reduced accidents by two-thirds in the case of various American roads and up to five-sixths on the German *autobahnen*. In some cases results are even more striking; accidents on Chicago's Outer (Lake Shore) Drive are 8 per 10,000,000 vehicle-miles, compared with an average of 189 for other roads in the area.

Apart from taking spectacular steps, such as building new roads, an enormous amount has been done in some places, such as Sweden, by plotting all road accidents on large-scale maps, undertaking *ad hoc* investigations at places where a number of accidents have occurred, and effecting local improvements with the object of reducing the frequency of accidents, with follow-ups to see how far this objective has been achieved. The application of fairly cheap common-sense measures can do a great deal to reduce the opportunities for the chief types of accident, those between vehicles moving in different traffic streams, which usually occur at road junctions, and those between vehicles and pedestrians walking in the carriageway, which chiefly occur in shopping areas.

SAVING IN TYRES

A radical improvement of the road system might be expected to produce economies under two other heads, saving of tyres, and saving in vehicle maintenance and repair. The total expenditure on tyres last year was about £20,000,000, and a saving of 15 per cent of this sum would therefore be £3,000,000. Such a saving ought not to be impossible. Tyre wear is primarily a function of acceleration and deceleration, and of changes in direction and of the speeds at which these take place. According to investigations undertaken at the Iowa State College, a single stop and start at 35 m.p.h. wears away as much rubber as a mile of travel. Investigations undertaken around London have suggested that undesired stops may amount to as many as 40 per 100 miles of travel, and, in addition to actual undesired stops, traffic friction, which could be greatly reduced by a modernized urban road system, occasions great numbers of accelerations and decelerations, and changes of direction not accompanied by stops,

but all leading to unnecessary tyre wear.

SAVING IN VEHICLE MAINTENANCE AND REPAIRS

The target for saving in vehicle maintenance and repairs is much greater than in the case of tyres, but the amount of saving which might result from a better road system is particularly difficult to assess with any reasonable degree of accuracy. In 1946, some £88,000,000 was spent on vehicle maintenance, and a 10 per cent saving in this figure, which might be taken as a reasonable target, would be £9,000,000. Pre-war German research suggested that great reductions in wear and tear followed the use of the new motor roads, provided that vehicles travelled at comparable speeds. If vehicles were over-driven on the new roads, there was of course wear and tear to be offset against the saving in time. Taking two points 100 miles apart on the German roads, it was found that gear changes on the motor road numbered 4, and on the old road 102. Brake applications numbered 3 on the motor road, and 491 on the old road; manipulations of the steering wheel of more than 2·3 inches numbered 570 on the old road, and one on the new. I think the old road must have been a particularly bad one, but the figures do suggest that, at the same speeds, the mechanical strain on vehicles using new roads should be much less than on the old roads.

SCOPE FOR SAVING IN ROAD VEHICLE OPERATING COSTS

Summarizing the various savings which could be expected to accrue from a modernized road system, there is, as Fig. 2 shows, scope for a total saving of £60,000,000 a year in road vehicle operating costs, on the basis of the restricted traffic carried in 1946. As fuel supplies become easier and more vehicles become available for the home market, this figure will increase. To set against this, there is the estimate of the cost of modernizing the British road system. This has been calculated at £550,000,000, a total which would include 1,000 miles of motorways, the provision of 200 miles of main traffic arteries in London and similar reconstruction of the larger provincial towns, with also a quite ambitious programme for smaller towns and country roads. This is shown in Fig. 3. This programme obviously could not be completed at once; spread over 10 years, it would cost £55,000,000 a year, and such an investment might be expected, once the improvements had been completed, to yield a dividend beginning at £60,000,000 a year, or 11 per cent, and thereafter rising with the expansion of traffic, and continuing indefinitely.

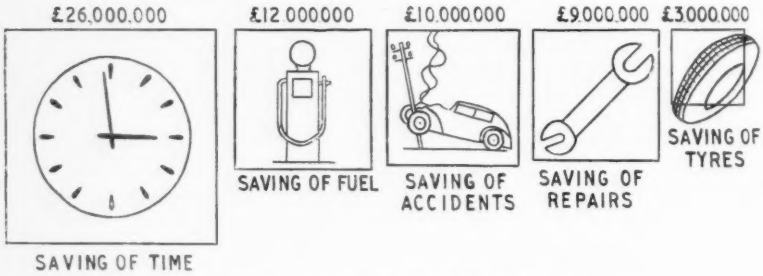


Fig. 2.—Annual saving in vehicle operating costs.

SOUNDNESS OF METHOD OF APPROACH TO ROAD PROBLEMS

Now, in conclusion, it may be argued that many of my figures are quite hypothetical. I agree that when methods, which can be used with a fair degree of accuracy in assessing the economics of a scheme for improving a particular stretch of road, are applied to the road system as a whole, a great deal of estimating must be done on a somewhat slender basis of ascertained fact. I, nevertheless, maintain that the method I have used of approaching the problem of investing more money in the road system is the right one, and is sound. If further research and the provision of more detailed information should prove that some of my estimates need correction, they must, of course, be corrected. That is all to the good. I would suggest, however, that my provisional estimates nevertheless provide a useful yardstick, and that they indicate that there is a first-class case, as soon as the present economic crisis has been resolved, for undertaking a thoroughgoing modernization of the road system as a paying proposition on its own merits, and as a most useful contribution to Britain's technical efficiency.

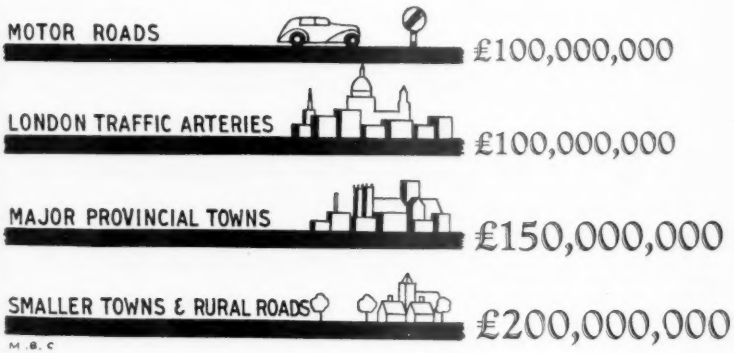


Fig. 3.—Minimum programme of road modernization.

BRITISH PETROLEUM EQUIPMENT NEWS

A new journal which has just made its appearance is *British Petroleum Equipment News*, which is to be published quarterly by the Council of British Manufacturers of Petroleum Equipment. Summing up the purpose of the publication, the introduction states that "it can become the accepted medium for the exchange of views between oil companies and manufacturers." Price is 2*s.* 6*d.* per copy (10*s.* 6*d.* per year post free).

DIESEL ENGINE USERS ASSOCIATION

The D.E.U.A. announces that its officers and committee for 1948 are: *President*, W. Howes; *Hon. Secretary*, J. S. Tritton; *Hon. Treasurer*, F. A. Greene; *Committee*, S. N. Boyne, A. K. Bruce, Maj.-Gen. A. E. Davidson, G. B. Fox, T. Hornbuckle, and F. J. Mayor.

A pamphlet dealing with **Preformed Ropes** has been issued by British Ropes Ltd., Doncaster.

VLADIMIR N. IPATIEV

On November 9, 1947, Vladimir N. Ipatiev, one of the greatest of Petroleum chemists, celebrated his eightieth birthday. This happy event was marked by congratulations from all over the world, including a cable from the Council of the Institute of Petroleum, and by an appreciation of Professor Ipatiev delivered by Dr Gustav Egloff before the Chicago Section of the American Chemical Society.

The name of Ipatiev is indissolubly linked with hydrocarbon chemistry, with catalytic and high pressure reactions, hydrogenation and dehydrogenation, isomerization, and polymerization. Much of his important work has been carried out in the United States of America; but before this phase started, Ipatiev had already had a remarkable career with many outstanding achievements to his credit.

Vladimir Ipatiev was born on November 9, 1867, in Moscow, and received his earlier education in Russia. Although trained at the beginning for a military career, at a military gymnasium and then at the Mikhail Military Artillery Academy, Ipatiev's strong interest in chemistry soon showed itself. In 1892 he was appointed instructor in chemistry at the Academy. In his earlier days, he had the advantage of coming into contact with such great chemists as Mendeleef and Menschutkin, and in 1896 he entered Baeyer's Laboratory at Munich where he met and worked with Villeger, Willstätter, Gomberg, and Thiele. After this he worked for a time in France and again met many chemists who have left their mark on science—Fittig, Vielle, Berthelot, and Friedel.

At the age of 32, he was elected as first Professor of Chemistry at the Artillery Academy, and soon commenced the series of investigations on the subjects on which he was to do so much work. The first of these was called "The Pyrogenetic Reactions of Organic Compounds" and he went on to study the catalytic reactions of hydrocarbons and then to work on the effects of high pressures—in the region of 450 atmospheres at 500 C. Much of this work was not practically applied for many years, but has since proved of outstanding interest.

During the next years Ipatiev studied many subjects of petroleum interest—catalytic reactions, the polymerization of ethylene under pressure, cyclization, the origin of petroleum, and many others. As time went on, he took more interest in the practical application of science to industry and undertook much work of an organizing nature, becoming largely responsible for the chemical industry of Russia at the beginning of the 1914–18 war, in which he attained the rank of Lieutenant-General.

After the war, and the Revolution, his work was directed to chemical industry and to more purely scientific investigations.

In 1930, at the World Power Conference in Berlin, he met Dr Egloff, and in the same year, at the age of 64, he left Russia for the United States and settled there as chemical adviser to the Universal Oil Products Co. and as professor in the North Western University, Illinois.

At an age when most men think of retirement, he commenced one of the most important phases of his life's work and his discoveries and publications in the field of hydrocarbon chemistry in the past seventeen years have had a very great influence on the development of modern petroleum refining and on the technique of chemical industry. Space precludes a list of his numerous contributions to chemical science, but mention should be made of his book, *Catalytic Reactions of High Temperatures and Pressures*, published some years ago; and he is still actively at work.

Ipatiev has received many honours, including membership of both the

Russian and American National Academies of Science and the award of the Willard Gibbs Medal of the American Chemical Society. He has a remarkable record both of chemical achievement and in the application of science to industry and is, in addition, an inspiring teacher who enjoys the regard and esteem of all his scientific colleagues.

All who know him or his work will wish him many more years of fruitful endeavour.

PERSONAL NOTES

Our hearty congratulations to *Dr A. E. Dunstan* on his seventieth anniversary, which he celebrated on January 25, and our best wishes for his enjoyment of many more celebrations. He has recently removed to Cambridge where he intends to carry out some research work in the Cavendish Laboratory.

S. T. Waite, F.Inst.Pet., has recently been appointed chief geologist with the Anglo-Egyptian Oilfields Ltd. He was previously in Trinidad with United British Oilfields of Trinidad Ltd.

S. H. Edwards, M.Inst.Pet., laboratory manager of Shell Co. of New Zealand Ltd. is at present in England for a short visit.

Dr. Ir. J. Ph. Pfeiffer, whose death was announced recently, was particularly well-known for his work in relation to bitumen. He joined the Bataafsche Petroleum Maatschappij in 1929 and at the time of his death was director of research of the company's laboratory.

R. M. Gillies, London manager of G. & J. Weir Ltd., who retired at the end of 1947 after 29 years in this position, has been succeeded by *Andrew W. Smith*. Mr Smith has been 17 years in the firm's employ.

Booklet No. 1C-1047 of the Oil Well Supply Co. gives a detailed description of Mechanical Drilling Rigs.

MODERN APPLICATIONS OF LIQUID FUELS

A Conference on Modern Applications of Liquid Fuels to be held in Birmingham in September, 1948, is being planned by a joint committee of the Institute of Fuel and the Institute of Petroleum. Chairman of the committee is J. A. Oriel, C.B.E., M.C.

THE INSTITUTE OF PETROLEUM

At the Annual General Meeting of the Corporate Members of the Institute of Petroleum to be held at the Royal Society of Arts on April 30, 1948, at 4.30 p.m., consideration will be given to and, if thought fit, the necessary resolution or resolutions will be passed for the alteration of certain existing By-Laws of the Institute.

A copy of the existing By-Laws and of the proposed alterations to these By-Laws are available for inspection by any member during normal business hours, and will continue to be so available until the Annual General Meeting is held for adopting these proposed amendments to the By-Laws.

Reprints of the **Batelle Memorial Institute** report of research on methods of improving the performance of the drill string are available from Spang-Chalfont Division of The National Supply Co., Pittsburg. The investigation was sponsored by the American Association of Oilwell Drilling Contractors.

Particulars of a new type of mechanical seal for oil refining process pumps are available from Flexibox Ltd., Twining Road, Trafford Park, Manchester 17.

PETROLEUM IN PARLIAMENT

Oil-burning Locomotives

The Minister of Transport was asked on February 9 how many locomotives have been converted to oil burning so far on each of the former systems of the G.W.R., L.M.S., L.N.E. and S.R.; and to what extent it is proposed that oil-burning shall supersede coal-burning locomotives in future policy.

In a written reply, the Minister said 37, 24, 1 and 31 respectively. Future policy is under consideration.

Diesel-Electric Locomotives

The numbers of diesel-electric locomotives engaged in traffic operations at December 31, 1947, were 45 on L.M.S., 1 on G.W.R., and 3 on S.R., said the Minister of Transport in a written reply on February 9. The numbers then under construction were 3, 6, and 11 respectively.

Petroleum Imports

U.K. imports of crude petroleum and refined liquid products from the Persian Gulf and the Dutch West Indies in 1947 were 22 and 37 per cent respectively of the total. For motor spirit only, imports from these two sources were respectively 9 and 35 per cent of the total, said the Minister of Fuel & Power in a written reply (February 9).

Gas Oil Imports

The Minister of Fuel & Power was asked on February 19 the amount of diesel oil which it is planned to import in 1948; how much of this will be used by motor buses and coaches; and the corresponding figures for 1947. In a written reply the Minister said: The Trade & Navigation Accounts show that imports of gas oil, which includes diesel oil used by motor buses and coaches, amounted in 1947 to about 1,600,000 tons. Subject to supply and tanker availability it is proposed to import about 1,800,000 tons of gas oil into the U.K. in 1948. The level of consumption of diesel oil by motor buses and coaches in 1948 may be slightly below the 1947 figure of 520,000 tons.

Anglo-Iranian Oil

On February 19 the Minister of Fuel & Power said he was aware that the Anglo-Iranian Oil Co. had recently been pumping oil back into their wells. This was not due to lack of markets but to the present serious deficiency in tanker tonnage.

Midlothian Oil and Coal

Asked on February 26 what coal measures were disclosed by oil boring operation at D'Arcy, Midlothian, the Minister of Fuel & Power said that a number of thin seams had been encountered, none of which exceeded one foot in thickness. He further said that he could not, without notice of the question, say whether any oil was encountered.

Coal-oil Conversion

The decision of the U.S.A. to hold up the issue of export licences for petrol and fuel oil would not affect allocations for approved coal-oil conversion schemes, said the Minister of Fuel & Power on February 26.

Middle East Oil Developments

Will H.M. Government take the initiative in approaching the Governments of the U.S.A., U.S.S.R., and France with a view to negotiating an amicable agreement with the Governments of the States comprising the Middle East for the joint assistance in the development of the oil resources of

these countries? This question was put to the Secretary of State for Foreign Affairs on March 1.

In a written reply, the Minister of State (Rt. Hon. Hector McNeil), said: No. As far as my right Hon. Friend is aware, the Governments of the Middle East have evinced no desire to receive any such joint assistance from the Governments of France, the U.S.A., the U.S.S.R., and the U.K.

LIQUID FUEL DEMAND IN 1948

WHILE all records for consumer demand for liquid fuels were broken in 1947, estimated 1948 demand will be even higher—16 per cent above the peak war year and 42 per cent above 1941, said Howard W. Page, executive assistant to the president of the Standard Ore Co. (New Jersey), in a recent broadcast in the United States.

One of the most important reasons for this tremendous demand, Mr Page declared, is the increase in home oil-burner installations—24 per cent more in use to-day than only 12 months ago.

All branches of the industry are operating at the highest rates ever achieved, he said, delivering 250 million gallons of oil products to the American public daily, or 3000 gallons every second. Though the supply is enormous, there is acute pressure on every branch of the industry. This is particularly true, he pointed out, in the 28 northern states east of the Rockies, where most of the new oil-burners have been installed.

Playing its part in U.S. expanding economy, the American oil industry is in the midst of the largest expansion programme ever contemplated, Mr Page noted. This involves a planned expenditure of four billion dollars during 1947 and 1948 to push exploration, drill wells, lay pipelines, build new refineries. "This work," he cautioned, "cannot be completed overnight."

The big question for the home and automobile owner, "Will there be enough heating oil this winter and enough gasoline next summer?" cannot be answered with any certainty, Mr Page declared, because there are too many "ifs" involved. The answer depends on the weather, on how fast government tankers are placed in service, on absence of shut-downs, and scores of other factors, he said. "The most important 'if' of all is whether consumers will use heating oil and gasoline prudently," Mr Page asserted.

U.S. NATURAL GAS INDUSTRY IN 1946

MARKETED production of natural gas in the United States in 1946 was 4,030,605 million cubic feet, an increase of 3 per cent over the 1945 peak of 3,918,686 million cu. ft. Figures issued by the Bureau of Mines, U.S. Department of the Interior, show that consumption also rose by 3 per cent over 1945 to 4,012,930 million cu. ft. Domestic consumption increased by 9 per cent, commercial consumption by 5 per cent, and total industrial consumption by 2 per cent. Details of 1946 consumption are:

	Million cu. ft.	*per cent of total*
Domestic	660,820	17
Commercial	241,802	6
Oil & gas fields (drilling, pumping, etc.)	897,809	22
Carbon black manufacture	478,349	12
Petroleum refineries	331,520	8
Portland cement plants	58,004	1
Miscellaneous industrial (including electric public utility power plants)	1,344,626	34
	4,012,930	100

Domestic consumers numbered 11,471,640 and commerical consumers 964,990, increases of 5 and 9 per cent respectively over 1945. Of these 8,817,130 domestic and 817,320 commercial consumers used 100 per cent natural gas, the remainder using mixed natural and manufactured gases.

STANDARD METHODS

for Testing Petroleum and its Products

IT is a characteristic of the petroleum industry that many of the novelties of yesterday are the commonplaces of to-day. No set of methods for testing petroleum products could long remain standard unless the effects of these changes in knowledge and interest were quickly incorporated. Brief study of the Ninth (1948) Edition of *Standard Methods* will, however, convince the reader that this publication is no dead thing; *Standard Methods* has long held its authoritative status, and this is being well maintained.

It is a far cry to the slim volume of the first edition of 1924, but the steady widening of interest is shown by the 608 pages devoted to technical matter, forty more than in the previous edition. Two previous methods have been withdrawn, one in favour of an improved method; while fifteen methods are either new or have been revised in detail more or less extensively. So that these modifications may not be overlooked by previous users of the volume, the parts of the text at which they occur have been marked with marginal lines—this in addition to their being listed in the introductory part of the book.

The Standardization Committee of the Institute of Petroleum is responsible for the methods, and the work of the Committee is discussed on broad lines in the Annual Report of its Chairman. The bases of his conclusions are given in greater detail in the Reports of the Chairmen of the fifteen controlling Sub-Committees under which the work of forty specialist Panels is coordinated. These reports, given in the introductory matter, discuss not only work achieved, but also work in hand or about to be undertaken. A list of members gives the names of those whose skilled experiments and advice have contributed to the year's work; besides many names well known in the industry, the list includes many representatives of Government Departments, of Associations working on related questions, and of users of petroleum products.

Nor has the care given to the preparation of the edition been limited to the purely technical side; the arrangement of indexes and incidental text has been carefully reconsidered, the results being reflected in the greater convenience of the book to its users.

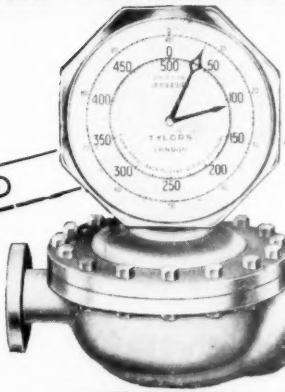
As was the case last year, supplies of paper have limited the number of copies available. The previous edition was completely sold out, and those who wish to make sure of obtaining a copy of the ninth edition are invited to place their orders as early as practicable. The price is 31*s*, post free.

BRITISH STANDARDS YEAR-BOOK, 1947

The British Standards Institution Yearbook for 1947 which has just made its appearance contains in its 324 pages a mass of information on the work of the B.S.I. up to March 31, 1947. All British Standards in existence at that date are listed in numerical order, with a summary of their contents, and a comprehensive subject index is provided. Lists are also given of changes since the last issue of the yearbook. Price of the yearbook is 3*s*. 6*d*. post free from the B.S.I., 24–28, Victoria Street, London, S.W.1.

National Supply Co's. latest bulletin describes a built-in fluid drive which is a feature of the company's new Sectional Drive Groups for consolidated rigs. Other recent bulletins include No. 332 on the type D-5 Unit Pumper, No. 338 on the Type D-21 Unit Pumper, and No. 347 on the Automatic Grip Elevator and Spider.

VOLUMETERS FOR OIL, PETROL AND OTHER PETROLEUM PRODUCTS



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FORTHCOMING MEETINGS

INSTITUTE MEETINGS

Properties of Paraffin Wax as an Effect of Composition. S. T. Minchin. At 26 Portland Place, London, W.1, 5.30 p.m. (Tea 5 p.m.), April 14.

The Chemical Evaluation of Oils of Medium Viscosity. C. H. Johnson. At 26 Portland Place, London, W.1, 5.30 p.m. (Tea 5 p.m.), May 12.

NORTHERN BRANCH

Some Aspects of Modern Automotive Design and Development. C. L. Goodacre. At Engineers' Club, Manchester, 6 p.m., April 12.

Annual General Meeting. At Engineers' Club, Manchester, May 10.

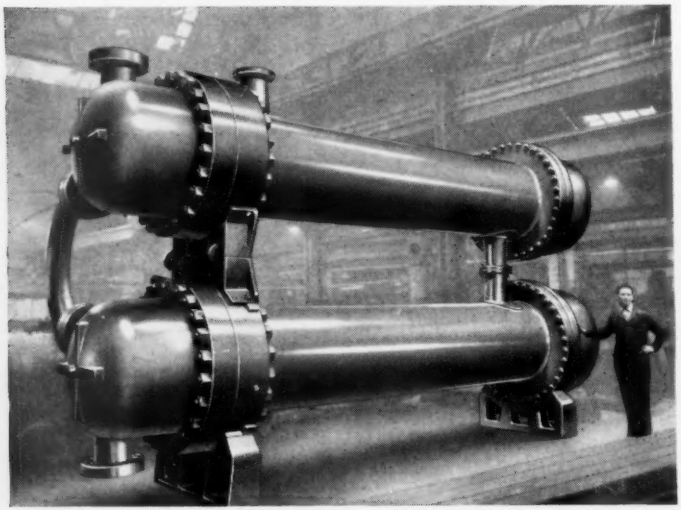
MEETINGS OF OTHER SOCIETIES

Automatic Control Applications in the Chemical Industry. H. Schmitt. Society of Instrument Technology, at College of Technology, Manchester, 7.15 p.m., April 13.

New work recently started by the **British Standards Institution** includes domestic appliances for liquid gas and also laboratory glassware (including condensers, beakers and flasks, filter and Buckner funnels, etc.). When draft specifications are available a further announcement will appear.

The Engineering & Industrial Equipment (Home and Export) Exhibition will be held at the Royal Horticultural Hall, London, May 19 to 28, 1948, inclusive. Originally planned for March, it is hoped that the new date will result in new products being then available for immediate delivery to home and overseas buyers.

HEAT EXCHANGE EQUIPMENT



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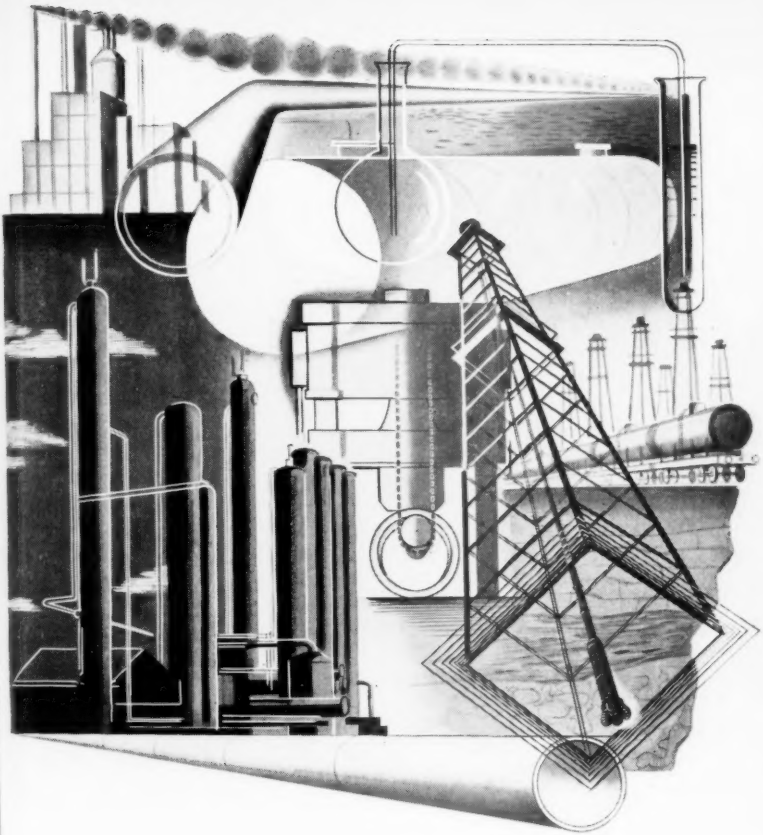

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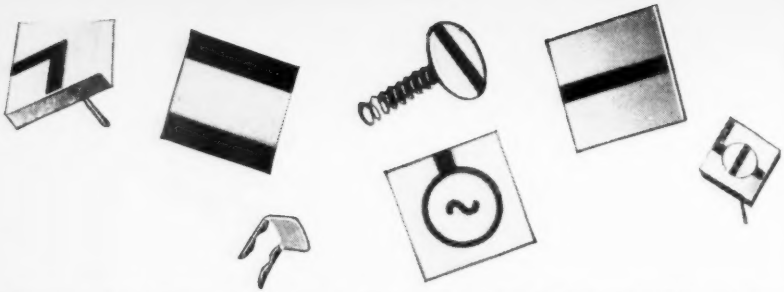

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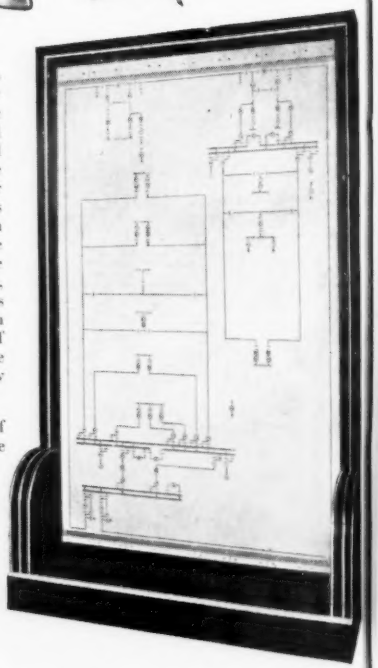

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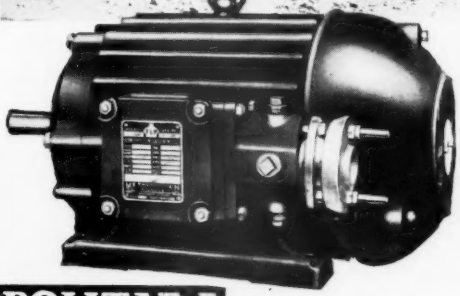

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